DRAFT

REVIEW OF OBSERVED PLUTONIUM-239,240 AND AMERICIUM-241 IN OU2 RUNOFF DURING THE MAY 16-17, 1995 FLOOD AT THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

OCTOBER 2, 1995

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS FIELD OFFICE

PREPARED BY:

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. . . protecting the environment

Sitewide Surface Water Group

CONTENTS

INTRODUCTION

The purpose of this report is to present storm water runoff sample data for plutonium-239, 240 and americium-241 in water collected downgradient from the 903 Pad and Lip Area (Operable Unit 2 (OU2)) (Figure 1) during an approximate 15-year rainfall event on May 16-17, 1995 at the Rocky Flats Environmental Technology Site (Site) (M. E. Smith, USGS, oral communication, May 1995). The Site received a considerable amount of precipitation prior to the May 16-17, 1995 event (Figure 2); producing saturated soil conditions prior to May 16. On May 16-17, 1995 the Site received about 3.58 inches of rain in about 15 hours, according to the Site Meteorology Tower data (Figure 2). At times, the rainfall was intense, producing flooding in Site drainages. Consequently, Site environmental scientists and engineers observed rare overland flow in OU2. Overland flow in the 903 Pad and Lip area flows from north to south into the South Interceptor Ditch (SID).

SAMPLE COLLECTION

During the storm, researchers studying the chemistry and mobility of plutonium in soils in OU2 as part of the OU2 Soil Studies Project, took samples of the overland runoff at locations shown in Figure 3. This opportunistic sampling task was done with little attention to experimental design due to time constraints. No formal quality assurance samples were collected. The samples were collected by bailing the runoff from shallow gullies using a polyethylene sample bottle with its top cut off. The bailed samples were placed in 1-Liter polyethylene containers and acidified with nitric acid to pH less than 2.0. The samples were shipped to Thermo Analytical (TMA) in Richmond, California for analysis of total plutonium-239,240 and americium-241 by alpha spectrometry. A telefax copy of the results from analyses of these samples is available for review (Attachment 1). The minimum detectable activities (MDAs) for the samples were not

reported, and no other water-quality samples were collected for correlation to the radionuclide activities.

DATA ANALYSIS AND INTERPRETATION

Few conclusions may be drawn from these data because no water-quality (e.g. total suspended solids) or flow data were obtained for correlation with the radionuclide activities. Comparison of total suspended solids concentrations and radionuclide activities would indicate the downgradient transport efficiency of soil materials eroded from the top of the hillside as well as the correlation of radionuclide activity with suspended solids concentration. Observation of the geographical distribution of the results combined with general reconnaissance of the study area are used herein to describe the importance of these results relevant to observed storm water quality in the SID and Pond C-2, located downstream from the OU2 study area.

It is generally accepted that plutonium-239,240 and americium-241 are physically partitioned to solids (e.g., soil particulates) (Harnish et al, in press; Litaor et al, 1994). Plutonium-239,240 and americium-241 activities in the runoff are as much as ten times higher at the top of the hill than at the bottom (Figure 3). Historical data for plutonium-239,240 and americium-241 for soils on the hillside show a similar trend toward decreased activity with downgradient distance from the 903 Pad (Attachment 2). Comparison of the soils data with the runoff data indicates that either very little actinide transport occurred over a long distance, or materials with high activity moved a very short distance downgradient. The actinide material in the overland flow might have been diluted or removed from suspension, or both processes may have occurred as the contaminated soil was transported downgradient.

An alternative explanation is that little transport occurred, and the observed radionuclide activities merely reflect the aerial distribution of actinide content in the

hillside material that was suspended in the runoff. Again, it is difficult to determine which mechanism(s) dominate the downgradient actinide transport without total suspended solids concentrations and flow data.

The runoff from OU2 might have contributed to the elevation in plutonium-239,240 activity in Pond C-2 measured on May 18, May 23, and May 30, 1995 (Attachment 3). However, an alternative hypothesis is that the actinide material in the SID is accumulated from a diffuse, non-point source of plutonium throughout the SID drainage, and this material is periodically flushed into Pond C-2, especially during storms of the magnitude measured on May 17, 1995. Plutonium-239,240 and americium-241 have been measured at elevated activities (0.3-2.3 pCi/L) in storm water runoff samples collected at gaging station SW027, located at the east end of the SID before it enters Pond C-2 (Attachment 4). The SW027 actinide data show that plutonium-239,240 and americium-241 are regularly detected in storm water sampled at this location. It is not known how much of the material detected at SW027 and in Pond C-2 comes from the OU2 drainage area versus other source areas.

There are other tributaries to the SID where elevated plutonium-239,240 activities were measured in storm water runoff, although not for the May 17 storm. These locations include gaging stations GS21 and GS24, both located on the 881 Hillside and receiving runoff from waste storage areas (Attachments 5 & 6). Data for several storm water runoff samples from gaging stations GS22 and GS25 indicate that runoff from the Building 460 Area and the east side of Building 881 respectively, do not contain high radionuclide activity; eliminating these drainage areas as significant actinide sources to the SID. A tributary suspected of contributing plutonium-239,240 activity in storm water runoff is a gully which flows intermittently from station SW055 south to the SID (Figure 1). This tributary was not sampled during the May 16-17, 1995 event.

A summary of total plutonium-239, 240 and americium-241 activities in storm water obtained from the OU2 drainage (May 17, 1995); gaging station SW027 (May 16 and 27, June 28, 1995); and Pond
C-2 (May 18-19, May 20-26, and May 27 - June 2, 1995) is shown in Figure 4. Results for Pond C-2 and SW027 were previously reported to downstream communities, the State of Colorado, and other stakeholders on June 28, 1995 and July 25, 1995. Water discharged from Pond C-2 (May 18-June 11, 1995) exceeded the Site-specific discharge limit of 0.05 picocuries per liter (pCi/L) plutonium-239,240. The Pond C-2 water was discharged to the Broomfield Diversion Ditch which routes the flow away from any public drinking water supplies. There was no danger to public health as gross alpha activities were below the State drinking water standard of 15 pCi/L.

CONCLUSIONS

The data analysis suggests the following conclusions.

1. A source of actinide material is located at the top of the OU2 hillside, and this material might be diluted and / or settled out of suspension as it is transported downgradient. It is difficult to determine which of these mechanisms dominate the downgradient actinide transport without total suspended solids and flow data.
2. The runoff data from OU2 could merely represent the aerial distribution of radionuclide activities in the hillside soils; not transport from a source located at the top of the hill.
3. The OU2 runoff data from the May 16-17, 1995 event might explain some of the variation in plutonium-239,240 activity measured in Pond C-2 on May 18, May 23, and May 30, 1995.
4. The OU2 runoff sample data provide additional evidence that the 903 Pad and surrounding area should continue to be a top priority for accelerated remedial action.

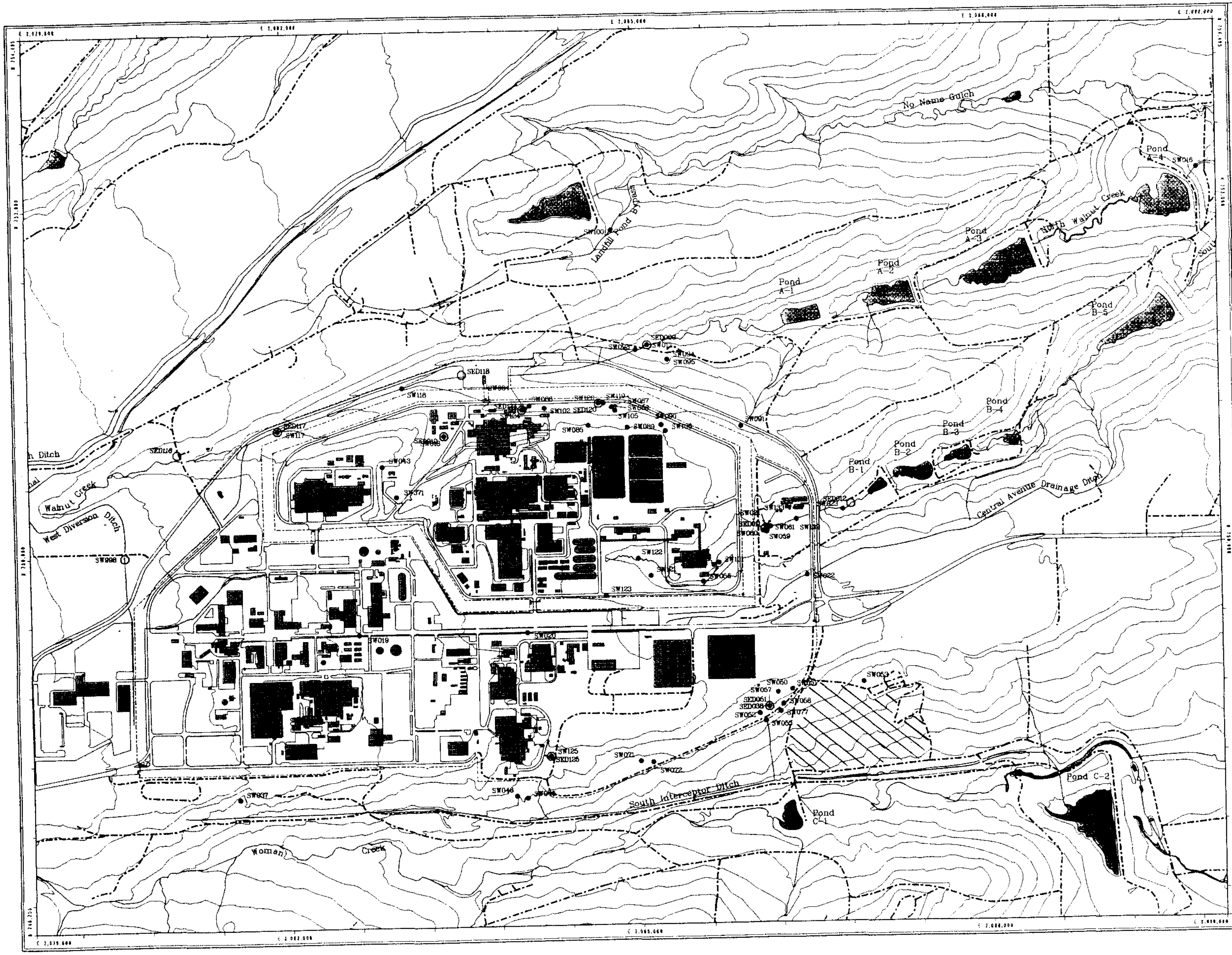
The OU2 overland runoff samples were collected as ad-hoc samples during a very unusual precipitation event as part of a research study for characterization of plutonium fate and transport in OU2 soils. If there is a need to determine the relative contribution of actinides from different drainage areas within the SID drainage, then a complete loading analysis of the SID is recommended. The loading analysis would require simultaneous measurement of flow and water quality in each major SID tributary for computation of actinide loads. A loading analysis of the SID would be difficult to complete in a reasonable time frame due to the infrequent occurrence of runoff events in this drainage.

REFERENCES

Harnish, R.A., McKnight, D.M., Ranville, J.F., Stephens, V.C., and Orem, W., In Press, "Particulate, Colloidal, and Dissolved-Phase Associations of Plutonium, Americium, and Uranium in Water Samples from Well 1587, Surface Water SW051, and Surface Water SW053 at the Rocky Flats Plant, Colorado," 29 p.

Litaor, M.I., Thompson, M.L., Barth, G.R., and Molzer, P.C., November-December 1994, "Plutonium- 239,240 and Americium-241 in Soils East of Rocky Flats, Colorado," in Journal of Environmental Quality, Vol. 23, no. 6, November-December 1994, Madison, WI, pp. 1231- 1239.

FIGURES



Rocky Flats Environmental Technology Site Industrial Area Historical Surface Water and Sediment Sampling Locations

- ● Surface water sampling locations
- ○ Sediment sampling locations
- ○ NPDES storm water permit sampling sites

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - Date unknown

OU2 Study Area

Scale = 1 : 9760
1 inch represents 815 feet
250 0 500 1000ft

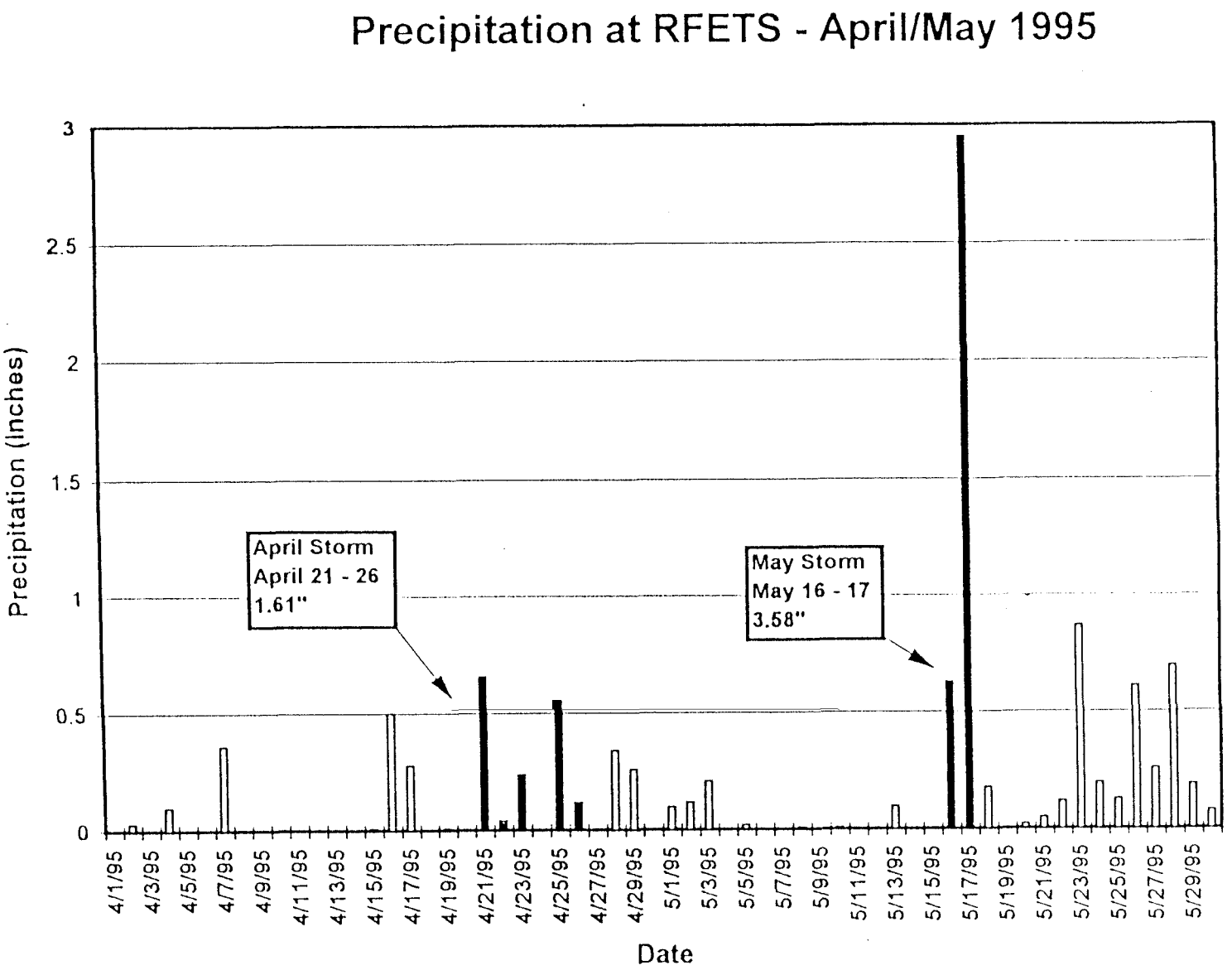
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Figure 1

/home/r518464/projects/wd/bs011194/sw-11x17.aml

Figure 2


Precipitation at RFETS - April/May 1995
Precipitation (Inches)
3
2.5
2
1.5
1
0.5
0
April Storm
April 21 - 26
1.61"
May Storm
May 16 - 17
3.58"
4/1/95
4/3/95
4/5/95
4/7/95
4/9/95
4/11/95
4/13/95
4/15/95
4/17/95
4/19/95
4/21/95
4/23/95
4/25/95
4/27/95
4/29/95
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5/13/95
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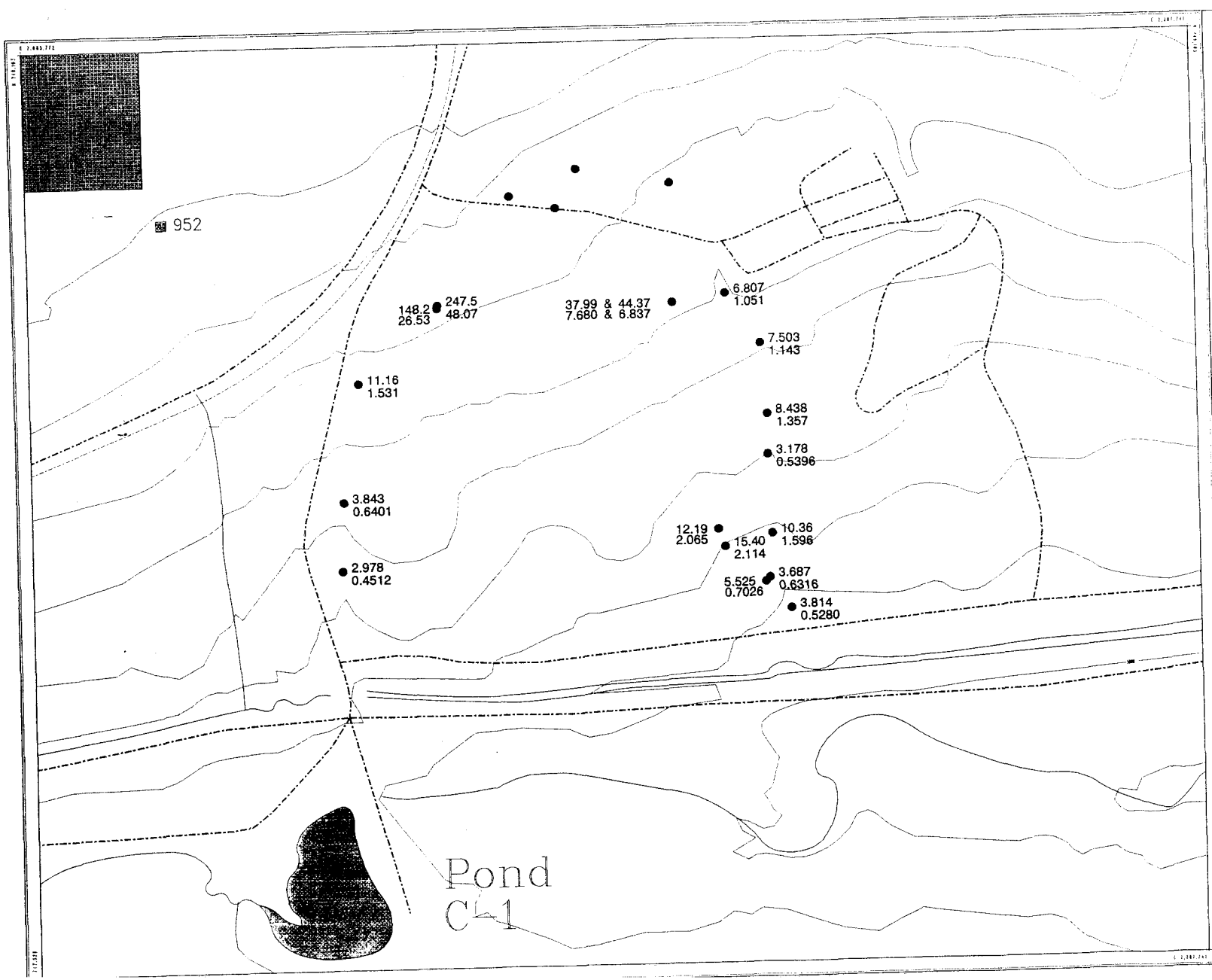
5/27/95
5/29/95
Date



Storm Event Sampling Locations

Figure 3

EXPLANATION

- Storm Event Sampling Locations
- Plutonium (Units in (pCi/l)
- Americium (Units in (pCi/l)
- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)
Storm Event Sampling Data provided by Michael Litaor of EG&G Rocky Flats - May 1995.

Scale = 1 : 1890
1 inch represents approximately 157.5 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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MAP ID: ***Draft***

September 19, 1995

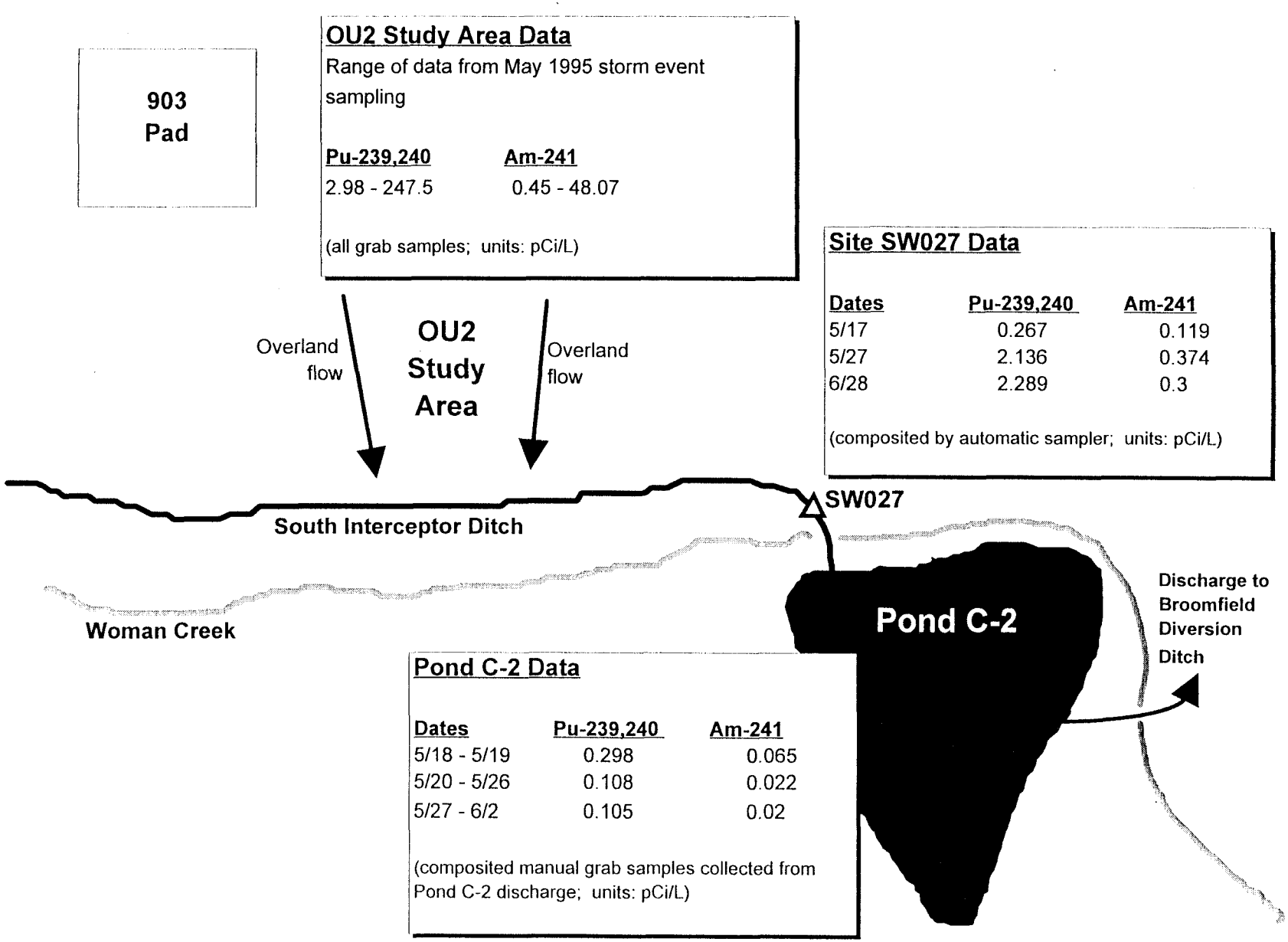

Figure 4. Schematic of May and June 1995 storm event samples in the vicinity of OU2.

ATTACHMENTS

TMA
Thermo Analytical

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ATTACHMENT 1

August 9, 1995

Results for samples SW00101ST through SW00117ST.

Sample ID	Results ± 2σ pCi/L Pu-239 •	Am-241 •
SW00101ST	3.814 ± 0.2820	0.5280 ± 0.05311
SW00102ST	3.687 ± 0.2846	0.6316 ± 0.05887
SW00103ST	10.36 ± 0.6985	1.596 ± 0.1020
SW00104ST	3.178 ± 0.3259	0.5396 ± 0.04001
SW00105ST	8.438 ± 0.7438	1.357 ± 0.1505
SW00106ST	7.503 ± 0.6824	1.143 ± 0.1007
SW00107ST	6.807 ± 0.6916	1.051 ± 0.09831
SW00108ST	5.525 ± 0.4879	0.7026 ± 0.05940
SW00109ST	15.40 ± 0.9333	2.114 ± 0.1944
SW00110ST	12.19 ± 0.7598	2.065 ± 0.2408
SW00111ST	3.843 ± 0.3080	0.6401 ± 0.03947
SW00112ST	2.978 ± 0.2273	0.4512 ± 0.03272
SW00113ST	11.16 ± 1.050	1.531 ± 0.1508
SW00114ST	247.5 ± 21.65	48.07 ± 5.098
SW00115ST	148.2 ± 14.81	26.53 ± 3.1180
SW00116ST	37.99 ± 3.377	6.837 ± 0.2353
SW00117ST	44.37 ± 3.374	7.680 ± 0.5787

ATTACHMENT 2

Location	Composite Period	Mid-Date, Composite	Pu-239-240	Pu, Std. Dev.	Am-241 (pCi/L)	Am, Std. Dev.	U-233,234 (pCi/L)	U-233,234, Std. Dev.	U-238 (pCi/L)	U-238, Std. Dev.	TSS, min	TSS, max	Gross Alpha, max (pCi/L)	Gross Alpha, Std. Dev.	Gross Beta, max (pCi/L)	Gross Beta, Std. Dev.
Pond C-2	5/18/95-5/19/95	5/18/95	0.298	0.063	0.065	0.022	1.02	0.21	1.41	0.28	18	27	3	1	7	2
	5/20/95-5/26/95	5/23/95	0.108	0.028	0.022	0.012	1.15	0.15	1.6	0.2	9	10	5	2	8	3
	5/27/95-6/2/95	5/30/95	0.105	0.018*	0.02	0.009	1.27	0.14	2.11	0.22	11	18	3	2	6	2
Volume Weighted Average			0.121	0.016	0.024	0.007	1.19	0.09	1.82	0.14						

ATTACHMENT 3

* - Result is reported as conditional; sample recovery is less than QA requirements. All other QA acceptable.

Industrial Area IM/IRA Storm Water Runoff (pCi/L)

Station	Sample Number	Date	Time	Pu-239,240	EPu-239	Am-241	EAm-241	U-233,234	EU-233,234	U-238	EU-238	Gross Alpha	Error Gross Alpha	Gross Beta	Error Gross Beta
SW027	SW00312EG	950517	310	0.267	0.018	0.119	0.014	0.787	0.048	0.858	0.051	6	2	9	2
SW027	SW00325EG	950527	51	2.136	0.085	0.374	0.029	2.505	0.097	5.056	0.178	13	3	10	4
SW027	SW00338EG	950628	2054	2.289	0.09	0.3	0.023	1.991	0.085	3.253	0.127	11	2	10	1

ATTACHMENT 4

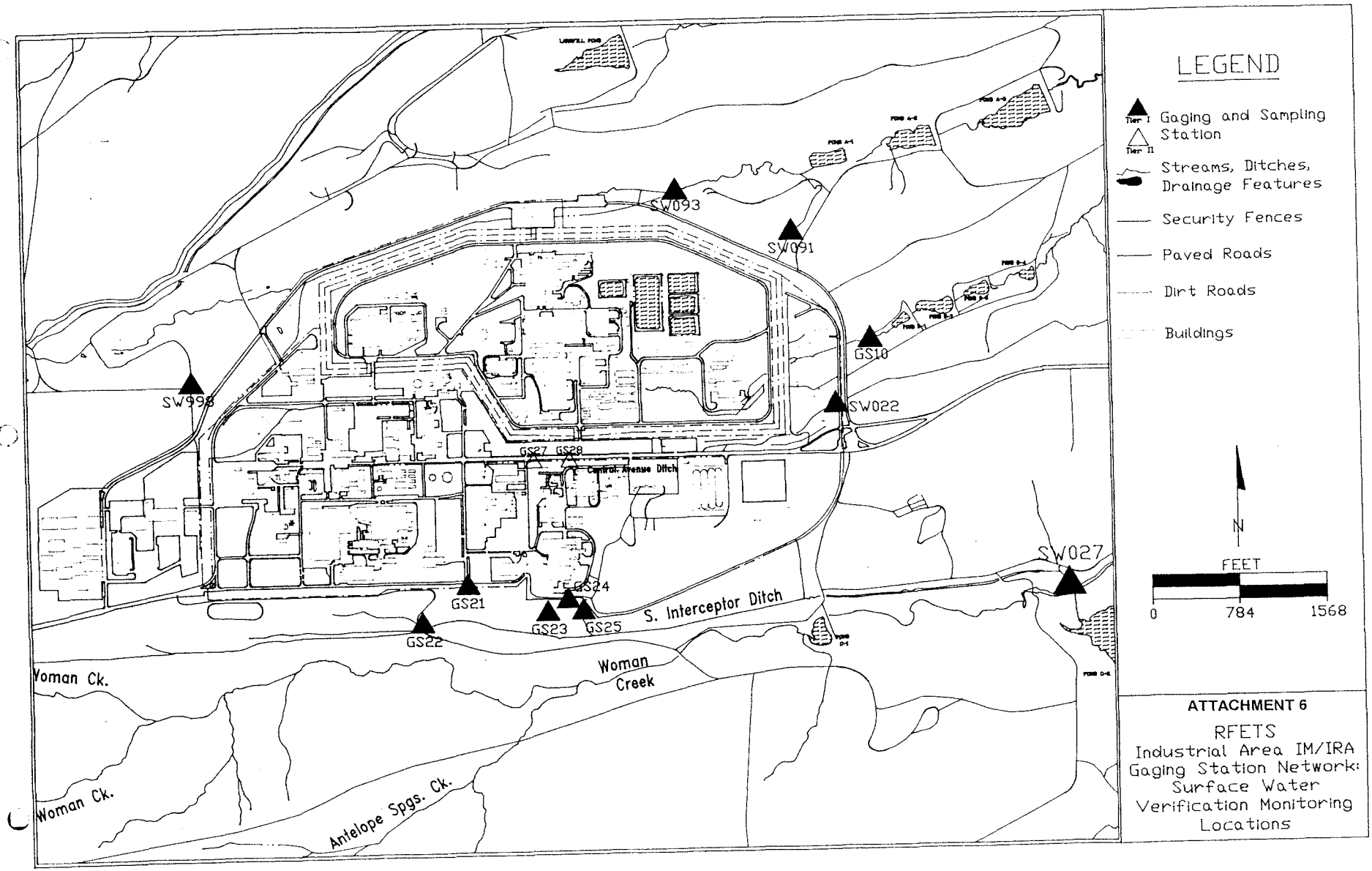
EPu-239,240 = Error term for Pu-239,240 analysis; EAm-241 = Error term for Am-241 analysis, etc. Data are preliminary and subject to revision.

Industrial Area IM/IRA Storm Water Runoff (pCi/L)

Station	Sample Number	Date	Time	Pu-239,240	EPu-239	Am-241	EAm-241	U-233,234	EU-233,234	U-238	EU-238	Gross Alpha	Error Gross Alpha	Gross Beta	Error Gross Beta
GS21	SW00308EG	950503	1639	0.104	0.014	0.013	0.006	0.129	0.019	0.112	0.018	4	1	5.5	2
GS21	SW00313EG	950516	2059	0.031	0.006	0.062	0.009	0.363	0.026	0.486	0.031	6	2	10	2
GS21	SW00327EG	950531	1634	0.004	0.003	0.017	0.004	0.124	0.014	0.072	0.011	7	2	16	2
GS21	SW00339EG	950628	1548	0.045	0.007	0.021	0.005	0.269	0.021	0.17	0.016	7	2	18	2
GS22	SW00307EG	950503	1341	0.007	0.005	0.018	0.008	0.718	0.054	0.67	0.055	4	1	7	2
GS22	SW00314EG	950516	1851	0.027	0.006	0.064	0.011	0.198	0.018	0.172	0.016	2	1	8	2
GS22	SW00328EG	950531	1633	0.002	0.002	0.007	0.004	0.227	0.018	0.247	0.019	6	1	16	2
GS22	SW00340EG	950628	1547	0.008	0.003	0.009	0.004	0.325	0.024	0.261	0.021	5	1	15	2
GS23	SW00331EG	950617	657	0.013	0.004	0.453	0.016	2.599	0.108	0.963	0.051	4	1	5	1
GS24	SW00306EG	950502	1916	0.128	.	0.04	.	1.952	.	0.683	.	18	4	26	3
GS24	SW00318EG	950516	2048	0.025	0.005	0.015	0.004	0.799	0.042	0.297	0.022	10	2	14	2
GS24	SW00341EG	950628	1549	0.209	0.016	0.048	0.015	1.138	0.056	0.623	0.037	19	5	34	3
GS25	SW00305EG	950502	1917	0.036	.	0.012	.	3.5	.	1.7	.	7	2	9	2
GS25	SW00317EG	950516	2035	0.02	0.004	0.006	0.002	1.053	0.051	0.614	0.035	4	1	6	2
GS25	SW00342EG	950628	1549	0.037	0.006	0.029	0.007	0.481	0.029	0.254	0.02	10	2	15	2

ATTACHMENT 5

EPu-239,240 = Error term for Pu-239,240 analysis; EAm-241 = Error term for Am-241 analysis, etc. Data are preliminary and subject to revision.



ATTACHMENT 6

RFETS
Industrial Area IM/IRA
Gaging Station Network:
Surface Water
Verification Monitoring
Locations